Dobutamine stress echocardiography after coronary artery bypass grafting

Transthoracic vs biplane transoesophageal imaging

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Graft failure or progressive native vessel disease can be a serious problem after coronary artery bypass grafting. However, because of poor image quality it may be difficult to evaluate these patients by transthoracic stress echocardiography. The purpose of this study, therefore, was to evaluate the effectiveness of dobutamine stress echocardiography in the detection of myocardial territories with compromised vascular supply (due to either an obstructed native vessel without graft, an obstructed graft, or a native vessel obstructed distal to bypass graft insertion with ≤50% luminal diameter reduction on angiography) after coronary artery bypass grafting and to determine additional information obtained by biplane transoesophageal stress echocardiography.

Sixty patients (54 men, mean age 59 ± 8.5 years) who had undergone coronary bypass grafting (total number of graft vessels 198) were evaluated from 6 months to 14 years (mean 6.2 years) after surgery. Transthoracic dobutamine stress echocardiography, biplane transoesophageal dobutamine stress echo, and coronary angiography were performed and evaluated by independent examiners. An infusion of dobutamine up to a maximum of 40 μg . kg⁻¹ . min⁻¹ was administered, and additional atropine (0.25—1.0 mg) was given if 85% of age-predicted maximal heart rate was not reached. Biplane transoesophageal echocardiography was performed in the transgastric short-axis view as well as transoesophageal 4- and 2-chamber views, allowing division of the left ventricle into a 14-segment scheme. Wall motion abnormalities induced with dobutamine stress were used to predict regional vascular insufficiency. A 4-point scale, ranging from 'excellent' (1) to 'impossible' (4) was used to assess each system's ability to evaluate all left ventricular segments.

Forty-five patients, of whom 35 were identified by transthoracic echocardiography (sensitivity 78%), had at least one territory with a compromised vascular supply. In 15 patients, the vascular supply was uncompromised, with 13 showing no wall motion abnormalities inducible by transthoracic echocardiography (specificity 86%). However, biplane transoesophageal echocardiography had a higher sensitivity and specificity than transthoracic echocardiography in detecting compromised vascular supply, 93% and 93%, respectively. The former system correctly classified the vascular supplies in 113 of 120 vascular territories (94%), according to whether they were compromised or uncompromised. This was significantly more (P<0.05) than by classification with transthoracic dobutamine echocardiography, by which system only 102 of the 120 vascular territories were correctly assessed (85%). Compared with the conventional transgastric monoplane short-axis view, examination using three different views via a biplane probe results in a higher sensitivity (93% vs 84%). Assessed on a 4-point scale, the ability to evaluate all left ventricular segments was 2.3 ± 0.7 (mean ± SD) for transthoracic echocardiography and 1.7 ± 0.7 (P<0.01) for biplane transoesophageal echocardiography.

After coronary artery bypass grafting transthoracic dobutamine stress echocardiography has acceptable accuracy in the detection of regional vascular insufficiency. However, this accuracy can be improved using the higher image quality of transoesophageal echocardiography, combined with the advantages of several different views obtained by biplane transoesophageal echocardiography. (Eur Heart J 1996; 17: 222–229)

Key Words: Biplane transoesophageal echocardiography, coronary artery bypass grafting, dobutamine echocardiography.

Introduction

Although coronary artery bypass grafting is effective in patients with coronary artery disease, progression of the underlying disease in native vessels as well as the hazard of obstruction or occlusion of bypass grafts, are frequent
events. Occlusion rates in venous bypass grafts at ten years have been reported to approach 50%, while 75% of those remaining patent became diseased\(^1\)\(^-\)\(^3\). It has been shown that chest pain and exercise electrocardiograms lack adequate sensitivity for assessing patients after coronary bypass surgery due to previous myocardial infarction, medication or insufficient capacity to endure physical stress tests\(^4\)\(^-\)\(^6\). Dobutamine echocardiography has been demonstrated to be a useful technique for the detection of coronary artery disease, in that it enables the correlation of inducible wall motion abnormalities with coronary anatomy\(^7\)\(^-\)\(^9\). However, insufficient echo image quality is known to make diagnostic stress testing impossible in up to 10% of normal patients and in those who have undergone coronary artery bypass grafting, interpretability may be extremely limited\(^10\). Thus transoesophageal echocardiography with its much higher image quality is attractive, especially in this patient group.

Monoplane transoesophageal echocardiography with transgastric short axis imaging has been combined with atrial pacing stress for non-invasive assessment of coronary artery disease in patients with suboptimal transthoracic echo imaging\(^11\)\(^-\)\(^13\). However, this view only visualizes a limited number of wall segments and atrial pacing sometimes results in patient discomfort. The purpose of this study was (1) to evaluate dobutamine stress echocardiography as a non-invasive method for detection of coronary territories with compromised and uncompromised vascular supply in patients after coronary artery bypass grafting, and (2) to compare the diagnostic accuracy of biplane transoesophageal echocardiography using transgastric as well as transoesophageal views with transthoracic imaging.

**Methods**

**Patients**

The study population consisted of 60 patients followed-up in the outpatient department after coronary bypass surgery, and who had undergone dobutamine stress echocardiography and subsequently cardiac catheterization. The patients were selected consecutively after deciding that cardiac catheterization should be performed. The decision to perform cardiac catheterization was made by the attending physician on clinical grounds, signs of ischaemia in an exercise ECG, or both. Dobutamine stress echo was performed after obtaining written informed consent within 2 days before catheterization, but the result of the stress echo did not affect the decision to perform cardiac catheterization. There were 54 men and six women (mean age 59 ± 8.5 years) with between them 198 grafts (average number of graft vessels 3.3 ± 1.0; 34 patients with internal mammary bypass grafts). The interval between follow-up and surgery ranged from 6 months to 15 years (mean 6.4 years). At the time of evaluation, 39 patients had symptoms characterized as angina, 15 were asymptomatic and six had atypical chest pain. Antianginal medication was not stopped prior to examination; 26 patients were receiving beta-blocking agents, 43 patients nitrates and 32 patients calcium antagonists. Twenty-eight patients had a history of myocardial infarction.

**Coronary angiography**

All 60 patients underwent coronary angiography using the Judkins technique. The angiograms were interpreted by experienced angiographers who had no knowledge of the results of the dobutamine echocardiograms. Coronary stenoses were quantified by manually tracing the stenosed segments and then measuring the stenosed and reference segments to obtain the mean percent diameter stenosis of two orthogonal views. Compromised vascular supply was defined by any of the following criteria: 50% or more diameter stenosis in a graft, the coronary artery distal to the graft or a major coronary artery that had not been grafted. Complete revascularization was defined as the absence of any of these criteria.

**Dobutamine stress protocol**

Dobutamine infusion was started at a rate of 5 μg kg\(^{-1}\) min\(^{-1}\), and the dosage was increased every 3 min to 10, 20, 30 and 40 μg kg\(^{-1}\) min\(^{-1}\). In case 85% of age-predicted maximal heart rate was not reached 0.25 mg atropine was given every minute up to a maximum of 1.0 mg atropine i.v. A standard 12-lead ECG was recorded at baseline and at each dobutamine stress test. Endpoints were maximal dosage, development of new wall motion abnormalities, a heart rate of 85% of age-predicted maximal heart rate, horizontal or downsloping ST-segment depression of more than 0.2 mV 0.08 s after the J-point in at least two leads, or angina. For transthoracic as well as transoesophageal echocardiography identical dobutamine and atropine dosages were used in all patients.

**Echocardiography**

Transthoracic as well as biplane transoesophageal dobutamine stress echocardiography were performed by two independent examiners in all patients on the same day with a time interval of at least 120 min. Although the transthoracic study was always performed first, it did not affect the decision to perform the second stress test, using transoesophageal echocardiography. Echocardiograms were obtained using an Acuson echocardiography system with a 2.5 MHz transthoracic echo transducer and a 5.0 MHz biplane transoesophageal echo transducer.

**Transthoracic echocardiography**

The patients were placed in a left lateral decubitus position. Parasternal long- and short-axis, and apical 2- and 4-chamber views were acquired and recorded on VHS videotape for subsequent off-line analysis. Recordings were performed at each dobutamine dosage step.
Transoesophageal biplane echocardiography
The patients were studied again in the left lateral decubitus position. Lidocaine spray was used to achieve local anaesthesia of the oropharynx and 0.02 to 0.05 mg kg\(^{-1}\) midazolam was given intravenously for mild sedation. The left ventricle was examined in three different views: a short-axis view at the midpapillary level from a transgastric transducer position using the transverse transducer, a 4-chamber view from a transoesophageal position using the transverse transducer and a 2-chamber view from the same transoesophageal position using the longitudinal transducer. The transgastric long-axis view was not used because of unstable, non-reproducible views in 37 of 60 patients.

Analysis of echocardiograms
Echocardiograms were interpreted by two investigators who were blinded to patient data, the results of coronary angiography and the other dobutamine stress echocardiogram performed on the same patient. For analysis, rest and peak stress images were displayed side-by-side in a cine loop technique using an off-line analysing system incorporated in the Hewlett-Packard Sonos 1000. However, the video tape was available for review by the investigator. Analysis was performed in this fashion for both transthoracic and transoesophageal echocardiography. Regional wall motion was qualitatively graded as normal, hypokinetic, akinetic or dyskinetic for each segment and for semi-quantitative wall motion analysis a wall motion score was used (normal=1, hypokinetic=2, akinetic=3, dyskinetic=4). A normal response, indicating normal segmental perfusion, consisted of progressive increase in systolic myocardial thickening or wall motion, or both during sequential stages of dobutamine. An abnormal dobutamine echocardiogram was defined as reduction of wall motion or systolic thickening at any stage of the dobutamine infusion compared with the previous stage. For the transthoracic echo approach, a scheme according to the recommendations of the American Society of Echocardiography\(^{14}\), which divided the left ventricle into 16 segments, was used for grading wall motion (Fig. 1). Biplane transoesophageal echocardiography allowed visualization of 14 corresponding segments (Fig. 2). Segment 1 (basal, anterior septum) and segment 9 (basal, posterior wall) of the transthoracic 16-segment scheme could not be evaluated due to the lack of a transgastric long-axis view. Monoplane transoesophageal echocardiography allowed evaluation of six segments. Using this scoring system, an index of global left ventricular wall motion (wall motion score index) was calculated as the sum of scores in visualized segments divided by the number of segments visualized at baseline and peak stress for the transthoracic as well as biplane transoesophageal echocardiograms. Due to the overlap between left circumflex and right coronary artery perfusion territories, the territories of these two coronary arteries were considered as a single one, opposed to the left anterior descending territory. The absence of dobutamine-induced wall motion abnormalities within a territory was considered to represent uncompromised flow in all vessels in that territory.

To examine the value of the additional transoesophageal biplane views over the conventional monoplane transgastric view, changes in wall motion for the six monoplane segments were compared with those registered in the 14 segments evaluated by the biplane probe. A 4-point scale ranging from excellent ability to assess all left ventricular segments (1), restricted endocardial border detection in at least one segment (2), impossible assessment in at least one segment (3), to
Table 1  Sensitivities, specificities and accuracies for transthoracic dobutamine stress echocardiography as well as biplane and monoplane transoesophageal dobutamine stress echocardiography related to patients

<table>
<thead>
<tr>
<th></th>
<th>Sensitivity</th>
<th>95% CI</th>
<th>Specificity</th>
<th>95% CI</th>
<th>Accuracy</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>TTE</td>
<td>78%</td>
<td>(63,89)</td>
<td>86%</td>
<td>(60,98)</td>
<td>80%</td>
<td>(68,89)</td>
</tr>
<tr>
<td>Biplane TEE</td>
<td>93%</td>
<td>(82,99)</td>
<td>93%</td>
<td>(68,100)</td>
<td>93%</td>
<td>(84,98)</td>
</tr>
<tr>
<td>Monoplane TEE</td>
<td>84%</td>
<td>(71,94)</td>
<td>93%</td>
<td>(68,100)</td>
<td>87%</td>
<td>(75,94)</td>
</tr>
</tbody>
</table>

CI=confidence interval; TTE=transthoracic echocardiography; TEE=transoesophageal echocardiography.

impossibility to assess at least one coronary territory (4) was used to assess the image quality. This evaluation was applied to the transthoracic as well as the transoesophageal examinations. This rating system is a modification of the system described by Marwick et al.115.

Statistical analysis

Continuous variables are expressed as mean values ± SD. Student’s t-test was performed to determine significant differences between continuous variables. A level of 0.05 was considered statistically significant.

Results

Coronary angiography

By angiographic criteria, 15 of the 60 patients had no regional vascular insufficiency; 45 patients had compromised vascular supply, 27 of whom had obstruction of one vessel (13 patients LAD, five patients LCX, nine patients RCA) and in 18 patients more than one vessel was obstructed (seven patients LAD+RCA, three patients LAD+LCX, eight patients LCX+RCA). Five patients had insufficient vascular supply due to new obstructions of ungrafted vessels; in three patients there was obstruction of a native vessel distal to the insertion of a graft, in another three there were new obstructions of ungrafted vessels plus graft obstruction, and in 34 there was obstruction of one or more grafts.

Dobutamine stress testing

The average maximal dobutamine dosage was 34 ± 7 µg . kg⁻¹ . min⁻¹ and in 11 patients additional atropine was given. The rate-pressure product under maximal pharmacological stress was 19258 ± 3340 mmHg . min⁻¹ for the transthoracic stress test and 19094 ± 3280 mmHg . min⁻¹ for the transoesophageal stress test (ns). Fourteen patients developed chest pain during dobutamine stress, of whom 13 had compromised vascular supply (29% sensitivity and 93% specificity for detection of vascular insufficiency). Dobutamine ECG was positive in 20 patients with a sensitivity for detection of vascular insufficiency of 44% and a specificity of 77%.

Echocardiography

Transsthoracic dobutamine echocardiography

The average wall motion score index increased from 1.24 ± 0.27 at rest to 1.34 ± 0.28 at maximal stress. Patients with compromised regional vascular supply were detected with a sensitivity of 78% and a specificity of 86% (Table 1). With regard to the left anterior descending coronary artery (LAD) territory segments, which had impaired perfusion in 23 patients, sensitivity and specificity were 83% and 95%, respectively. For the combined right coronary artery/left circumflex artery region with compromised vascular supply in 32 patients, a sensitivity and specificity of 66% and 96%, respectively, was determined (Table 2). Transthoracic

Table 2  Transthoracic dobutamine stress echocardiography for detection of compromised vascular supply related to territories

<table>
<thead>
<tr>
<th>Territory</th>
<th>Compromised supply (n=23)</th>
<th>Uncompromised supply (n=37)</th>
</tr>
</thead>
<tbody>
<tr>
<td>LAD territories (n=60)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Positive echo</td>
<td>19</td>
<td>2</td>
</tr>
<tr>
<td>Negative echo</td>
<td>4</td>
<td>35</td>
</tr>
<tr>
<td>Sensitivity</td>
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<td></td>
</tr>
<tr>
<td>Specificity</td>
<td>95%</td>
<td></td>
</tr>
<tr>
<td>Accuracy</td>
<td>90%</td>
<td></td>
</tr>
<tr>
<td>RCA/LCX territories (n=60)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Positive echo</td>
<td>21</td>
<td>1</td>
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<td>Negative echo</td>
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<tr>
<td>Specificity</td>
<td>96%</td>
<td></td>
</tr>
<tr>
<td>Accuracy</td>
<td>80%</td>
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</tr>
</tbody>
</table>

Accuracy for LAD and RCA/LCX territories: 85%

LAD=left anterior descending coronary artery; RCA=right coronary artery; LCX=left circumflex artery.
dobutamine echocardiography correctly classified compromised and uncompromised vascular supply in 102 of the 120 vascular territories (85%). In 40 of 55 territories (73%) with compromised vascular supply the echo finding was positive, being negative in 62 of 65 territories (95%) with uncompromised vascular supply.

Transoesophageal dobutamine echocardiography
For the visualized biplane transoesophageal echocardiography wall segments, average wall motion score increased from 1-20 ± 0-26 at rest to 1-34 ± 0-31 with maximal dobutamine stress, non-significantly different compared to transthoracic echocardiography. Sensitivity (93%) as well as specificity (93%) for detection of patients with compromised and uncompromised vascular supply were higher with biplane transoesophageal dobutamine echocardiography compared with transthoracic echocardiography (Table 1). Figure 3 demonstrates an inducible wall motion abnormality of the anterior wall detected in the transoesophageal 2-chamber view in a patient with occlusion of the LAD graft. For the LAD territory, a sensitivity and specificity of 91% and 97%, respectively, were determined. For the combined RCA/LCX territory, sensitivity and specificity were 91% and 96%, respectively (Table 3). Transoesophageal dobutamine echocardiography correctly classified the

Figure 3 Two-chamber transoesophageal dobutamine echocardiography with an inducible wall motion abnormality of the anterior wall (arrows). The upper panel shows systolic and diastolic images at rest, the lower panel systolic and diastolic images at peak dobutamine dosage. Angiography confirmed total occlusion of the left coronary artery bypass graft.
Table 3 Biplane transoesophageal dobutamine stress echocardiography for detection of compromised vascular supply related to territories

<table>
<thead>
<tr>
<th>LAD territories (n=60)</th>
<th>Compromised supply (n=23)</th>
<th>Uncompromised supply (n=37)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positive echo</td>
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<td>1</td>
</tr>
<tr>
<td>Negative echo</td>
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<td>36</td>
</tr>
<tr>
<td>Sensitivity</td>
<td>91%</td>
<td></td>
</tr>
<tr>
<td>Specificity</td>
<td>97%</td>
<td></td>
</tr>
<tr>
<td>Accuracy</td>
<td>95%</td>
<td></td>
</tr>
<tr>
<td>RCA/LCX territories (n=60)</td>
<td>Compromised supply (n=32)</td>
<td>Uncompromised supply (n=28)</td>
</tr>
<tr>
<td>Positive echo</td>
<td>29</td>
<td>1</td>
</tr>
<tr>
<td>Negative echo</td>
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<td>27</td>
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<tr>
<td>Sensitivity</td>
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<td></td>
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<tr>
<td>Specificity</td>
<td>96%</td>
<td></td>
</tr>
<tr>
<td>Accuracy</td>
<td>93%</td>
<td></td>
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</tbody>
</table>

Accuracy for LAD and RCA/LCX territories: 94%

Abbreviations as for Table 2.

compromised and uncompromised vascular supply in 113 of 120 vascular territories (94%). Thus, accuracy in the detection of territories with compromised and uncompromised vascular supplies was significantly higher (P<0.05) with transoesophageal than transthoracic dobutamine echocardiography. Fifty-one of the 55 territories (93%) with a compromised vascular supply were correctly identified, significantly more than with the transthoracic approach (P<0.05). The identification of territories with an uncompromised vascular supply was successful in 63 of 65 territories (97%).

Although the transoesophageal stress echocardiographic examination detected additional patients with inducible wall motion abnormalities, there was complete agreement between transthoracic and transoesophageal imaging on the localization of resting and induced wall motion abnormalities in those patients already detected by the transthoracic approach.

Image quality related diagnostic accuracy

Image quality assessment on a 4-point scale ranging from excellent (1) to severely impaired (4) was 2.3 ± 0.7 for the transthoracic dobutamine stress examinations and 1.7 ± 0.7 (P<0.01) for the biplane transoesophageal stress echo examinations. Impairment of transthoracic echocardiographic image quality impeded visualization of at least one left ventricular segment in 23 patients. On the 4-point scale, four patients had grade 4 image quality and 19 had grade 3 image quality. For these patients, sensitivity and specificity for detection of compromised vascular supply was lower compared with the 37 patients with high image quality (grade 1 and 2) (Table 4). There were only seven patients with image qualities of grades 3 or 4 using transoesophageal echocardiography. Diagnostic accuracy for the group of 23 patients with impaired transthoracic image quality was high using transoesophageal echocardiography (Table 4).

The special advantage of transoesophageal dobutamine stress echocardiography in patients with impaired transthoracic image quality is reflected in the fact that five of the seven patients with compromised vascular supply detected additionally by transoesophageal examination had a transthoracic image quality of 3 or 4 on the 4 point scale. None of these patients had score 1 (excellent) transthoracic image quality.

Comparison of monoplane with biplane transoesophageal echocardiography

Monoplane transoesophageal echocardiography had a sensitivity of 84% for detection of compromised vascular supply, lower than biplane transoesophageal echocardiography, but higher than transthoracic echocardiography. Specificity was 93% and accuracy 87% (Table 1). An average of 0.9 segments/patient were detected by monoplane transoesophageal echocardiography to have inducible wall motion abnormalities, compared with an average of 1.8 segments/patients using biplane transoesophageal echocardiography (P<0.001). Thus, 54 additional segments with inducible wall motion abnormalities could be detected in the study population of 60 patients, these being in the basal or apical part of the left ventricle and not being registered by the conventional monoplane transgastric view.

Discussion

Background

The frequent occurrence of occluded or stenosed coronary artery bypass grafts combined with disease progression in native vessels results, within a few years of coronary artery bypass grafting, in a significant number of regions with compromised vascular supply.
Fitzgibbon et al.\textsuperscript{11} reported a graft occlusion rate of 20% at 5 years and of 41% at 10 years after operation with a high rate of patent grafts being diseased from atherosclerosis. Thus, an accurate non-invasive method for detection of regional vascular insufficiency in patients after coronary artery bypass grafting is desirable. However, postoperative exercise testing has been shown to have a poor correlation between ST segment changes and graft patency\textsuperscript{16,17}. Perfusion scintigraphy has been reported to have a sensitivity of 77–80% and a specificity of 88–100% for detecting or excluding graft occlusion\textsuperscript{18,19}.

Dobutamine stress echocardiography is an accurate method for the identification of coronary artery disease, with reported sensitivities and specificities in the range of 85 to 96% and 66 to 85%, respectively\textsuperscript{17–9,20}. After coronary artery bypass grafting, echocardiography may pose problems as regards acquisition and interpretation of images\textsuperscript{19} due to excessive cardiac motion, displacement of the heart and impaired echo penetration of the chest. This especially affects stress echocardiography. Therefore, the purpose of this study was twofold: to assess the value of dobutamine stress echocardiography for the detection of compromised vascular supply in patients after coronary artery bypass grafting, and to compare transthoracic echocardiography with biplane transesophageal echocardiography for this special aim.

Monoplane transesophageal echocardiography displaying the transgastric short-axis view has been used previously in combination with atrial pacing for detection of coronary artery disease\textsuperscript{11–13}. Norris et al.\textsuperscript{21} used a transesophageal biplane probe in combination with atrial pacing for detection of coronary artery disease. They examined the left ventricle from a transgastric position using the transverse as well as longitudinal plane and reported a sensitivity of 86% and a specificity of 89%. Agati et al.\textsuperscript{22} used a monoplane probe in a transgastric as well as a transesophageal position in combination with dipyridamole stress for detection of coronary artery disease in patients with an inadequate transthoracic echo window. A high sensitivity of 92% and a specificity of 100% were reported. The reported higher sensitivity for diagnosis of coronary artery disease compared with our study may be explained by their more restrictive definition of significant coronary artery disease as >70% luminal diameter narrowing. Furthermore, their study group was quite small, with a total of 32 patients including only eight patients without coronary artery disease. However, monoplane transesophageal echocardiography, especially if used only in the transgastric position, has the disadvantage of displaying only a limited number of wall segments. Thus, the application of a biplane probe appears to be advantageous.

**Transthoracic stress echo**

In this study, dobutamine stress echocardiography using the transthoracic approach proved to be useful for detection of regional vascular insufficiency in patients after coronary artery bypass grafting. Exercise echocardiography has been used by Sawada et al.\textsuperscript{23} for detection of compromised regional vascular supply, in patients after bypass grafting. They reported a sensitivity of 94% and a specificity of 83%. Crouse et al.\textsuperscript{24} also using exercise echocardiography reported a sensitivity of 98% and a specificity of 92% for detection of regional vascular insufficiency. However, in their study groups the results of the exercise echocardiograms influenced the decision to perform coronary angiography, which might have increased the reported sensitivity. Our sensitivity was slightly lower than those reported for dobutamine stress echo in patients with coronary artery disease but without prior coronary artery bypass grafting. This is due to several factors: (1) a lower overall image quality in patients after coronary artery bypass grafting, (2) antianginal therapy was not stopped prior to examination and (3) a high number of patients with prior myocardial infarction.

**Improved diagnostic accuracy of biplane transesophageal echocardiography**

Transesophageal echocardiography is known to have high image quality in most patients, and this study demonstrates that impaired transthoracic image quality results in decreased diagnostic accuracy. While there was no significant advantage as regards the diagnostic accuracy of transesophageal echocardiography for patients with high transthoracic image quality, those with unpaired transthoracic echo window gained significantly from the biplane transesophageal approach. Most patients detected additionally by biplane transesophageal echocardiography as having vascular insufficiency had low transthoracic image quality. The overall higher diagnostic accuracy of biplane transesophageal echocardiography may therefore be explained by the higher image quality in a higher number of patients. Monoplane transesophageal stress echocardiography is known to have satisfactory diagnostic accuracy due to high image quality in almost all patients. However, compared with monoplane transesophageal echocardiography using a short-axis view on the mid-papillary muscle level only, our approach with three views obtained by a biplane probe has the advantage that 14 of the 16 segments in left ventricular scheme could be evaluated instead of only six. Thus, apical and basal wall motion could also be evaluated, resulting in 54 segments with inducible wall motion abnormalities missed by monoplane short-axis imaging. Thus, the biplane technique had a higher sensitivity for compromised vascular supply (93% vs 84%) as new, induced, wall motion abnormalities affecting only basal or apical segments were detected. Biplane transesophageal stress echocardiography using three views combines therefore the advantages of a high endocardial resolution with a better evaluation of the whole left ventricle.
Study limitations

Although the result of the dobutamine stress test did not affect the decision to perform coronary angiography, patients were chosen on the basis of a strong clinical suspicion of disease progression, a positive exercise test or both. This introduces possible referral bias. The reported sensitivity and specificity for coronary territories, however, should not be affected by this problem.

The main disadvantage of transoesophageal echocardiography is its semi-invasiveness, requiring the passage of a probe into the oesophagus and stomach. This procedure can be unpleasant to the patient. The 2- and 4-chamber views which have to be acquired from an oesophageal position of the echo transducer may shorten the left ventricle if the tip of the echoscope is not kept in a slightly retroflected position. However, shortening of the left ventricle is also a problem of the apical transthoracic views.23 The 2- and 4-chamber views from the oesophageal position have the disadvantage that most parts of the endocardium are parallel to the echo beam; however, this drawback is less severe given the general improvement in image quality by transoesophageal echocardiography.

Clinical implications

Transthoracic dobutamine stress echocardiography offers acceptable accuracy for detection of regional vascular insufficiency in patients after coronary artery bypass grafting. In patients with impaired transthoracic echo windows it seems reasonable to use biplane transoesophageal echocardiography. This offers a higher diagnostic accuracy without the lack of basal and apical left ventricular evaluation, which has been a limitation of monoplane transoesophageal stress echocardiography.

References